HERACLES and DJANGO6: Updates for version 4.6.8 - 4.6.10

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Abstract

Modifications introduced into DJANGOH-4.6.8 to allow calculations for nuclear targets and for version 4.6.10: nucleon polarization.

1 File `lhaglue-copy.f`

- Parton distribution functions from LHAPDF required a modification in `lhaglue.f`. The modified version, `lhaglue-copy.f` is part of the DJANGOH source code now.
  - Removed reference to common block `/ludat1/` because of type mismatch with JETSET 7.4; removed the corresponding assignment to unused `mstu5(11)`.
  - To allow use of nuclear corrections from [3, 4, 5] via calls to `structm` from PYTHIA, `structm` in `lhaglue-copy.f` has been renamed to `structf` and `structa` into `structm`. The argument list of `structa` is shortened: the nuclear number `a` is transfered via the common block `/HSNUCL/` from DJANGOH.

2 File `djangoh_h.f`:

- To allow linkage to the LHAPDF library [1], initialization of the path to the PDFsets folder has been introduced in subroutine `HSWPDF` and the path name has to be provided in the input file with code word `LHAPATH`:

  `LHAPATHI`: Path name to the PDFsets folder of LHAPDF, character*80, no default defined.

  The code was tested with LHAPDF version 5.8.6.

- The new code word `NUCL-MOD` with input `INUMOD` (integer, default = 0) has been introduced to select a model for nuclear shadowing or nuclear parton distribution functions.
  The variable `INUMOD` extends the common block `/HSNUCL/`.

  `INUMOD` = 0: No correction. Parton distribution functions are used as selected by `ILQMOD, ILIB, ICODE` from code word `STRUCTFUNC`.
  This is the appropriate setting if nuclear parton distribution functions like those from [2] are used which incorporate nuclear effects.

  `INUMOD` = 1000: Structure functions are calculated from the isoscalar average of unmodified parton distribution functions and a Q^2-independent correction factor. The same correction factor is applied to both F_2 and F_L.

  `INUMOD` = 2000: Apply correction factors to free parton distribution functions from EKS98 [3].

  `INUMOD` = 3000: Apply correction factors to free parton distribution functions from EPS08 [4].

`INUMOD` > 4000: Apply correction factors to free parton distribution functions from EPS09 [5].
LO or NLO fits (`iorder` = 1 or 2) and the error set `ipset` = 1, ..., 23, are selected according to `INUMOD` = 100×`iorder` + `ipset`.
The EPS09 analysis is based on CTEQ6.1M partons, but any PDF set can be combined with the nuclear corrections in this scheme.

Code in subroutines `HSSTRF` and `HSSTR1` has been reorganized to allow for this option.

- Since version 4.6.10, the proton can be polarized [6]. The prescription for the calculation of the cross section is based on the parton model and distribution functions for polarized partons are used (see section 4, File `polpdf.f`). The following new input options are available:

  `HPOLAR`: The degree of the proton polarization. Input is expected as a second `double real` in one line after the proton energy, i.e. with the code word `PR-BEAM`. If not between -1 and $+1$, `HPOLAR` is set to zero. This variable extends the common block `HSPARM`.

  `POLPDF`: The new code word to read input for the selection of a parametrisation of polarized PDFs. Input for the integer variable `IDPVR` (on common block `HSSTRP`) is expected, where
  `IDPVR = 100*ISET+MODE`
  with the following meaning:

  `ISET` = 1: DSSV [7];
  `ISET` = 2: DNS [8];
  `ISET` = 3: DS [9];
  `ISET` = 4: GSLO [10];
  `ISET` = 5: GSNLO [10];
  `ISET` = 6: BB [11];
  `ISET` = 7: AAC [12];
  `ISET` = 8: LSS [13];
  `ISET` = 9: GRSV [14];

  The new subroutine `HSDPVR` provides an interface to the necessary code which is collected in file `polpdf.f` (see below). A separate routine (`HSCPVR`) is called after integration and after sampling to print out the number of counts for which x and Q^2 were outside the range of validity of the parametrisation for polarized PDFs.

- The new code word `OUTFILENAM` allows to give a name for output files. The input is of type `character*80` and has to start with a non-blank character. The output files are

- OUTFILENAM_out.dat is used for standard output. Redirection to the file starts after code word START appears in the input file;
- OUTFILENAM_smp.dat is used for sampling information needed for iterated calls;
- OUTFILENAM_rnd.dat takes information about the state of the random number generator;
- OUTFILENAM_his.paw is for histograms generated in the user routine contained in djangoh_u.f.

If no input to code word OUTFILENAM is given, standard output continues to appear at the console and the default name djangoh-default-output is used for the other output files.
Note that logical unit numbers 6, 8, 9, and 31 are used in the program (changed since version 4.6.10 to avoid a conflict with routines for polarized PDFs).

- If a negative value for input variable ISDINP (with code word RNDM-SEEDS) is given, the Cernlib random number generator ranlux is used with date and time as seed.

- A number of modifications was introduced to comply with gnu-fortran standards. The argument list of the subroutines DX1FCF and D01AJF was shortened and includes now used variables only

3 File djangoh_l.f:

- The target nucleon, proton or neutron, is chosen event by event according to its cross sections and using input from HNA and HNZ.

4 File polpdf.f:

- A collection of third-party code for polarized parton distribution functions. The most recent one (DSSV, [7]) is based on the most complete set of data and on theoretical calculations performed fully at next-to-leading order. The other programs were obtained from http://hepdata.cedar.ac.uk/pdfs.
The necessary grid-files are searched in a sub-directory called polpdf-gridfiles.

5 File gmc_random.f:

- Random number generator ranlux from Cernlib. The function PYR has been replaced by an interface to ranlux.

6 File djangoh_u.f:

- Filling of histograms is done with HFILL after a preceding call to HBARX. The present version in more accurate statistics with large event numbers. Output is written to file OUTFILENAM_evt.dat.

7 Usage

- Input to code word NUCLEUS is EPRO, the energy per nucleon, and HNA (nucleon number) and HNZ (proton number).
- Parton distribution functions are used from LHAPDF [1] if ILQMOD=0 and ILIB=2. Important values for the PDF set are

  ICODE = 10150: CTEQ61M. Note that this set was used as a reference in the EKS and EPS fits of nuclear correction factors to the PDFs.

  ICODE = 10550: CTEQ66.

  ICODE = 29061: MRST98dis.

  ICODE = 100151: HKNnlo for proton; in general: 100150+n with $n = 2$ (deuteron), $n = 3$ (Helium), $n = 6$ (C), $n = 17$ (Au), $n = 18$ (Pb), etc.
- For version 4.6.10, a test run was performed with input file erhic-nc-test.in and erhic-cc-test.in. The corresponding output files are named as described above with OUTFILENAM = erhic-nc-test and OUTFILENAM = erhic-cc-test.
  Generation of 1,000,000 events (including F_L and fully fragmented) took about 14 minutes on eic0001.rcf.bnl.gov (7.5×10^{-4} sec per event plus initialization).

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